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Lightning in California

The Journal of Electricity

AN ILLUSTRATED REVIEW OF THE INDUSTRIAL APPLICATIONS OF ELECTRICITY, GAS AND POWER.

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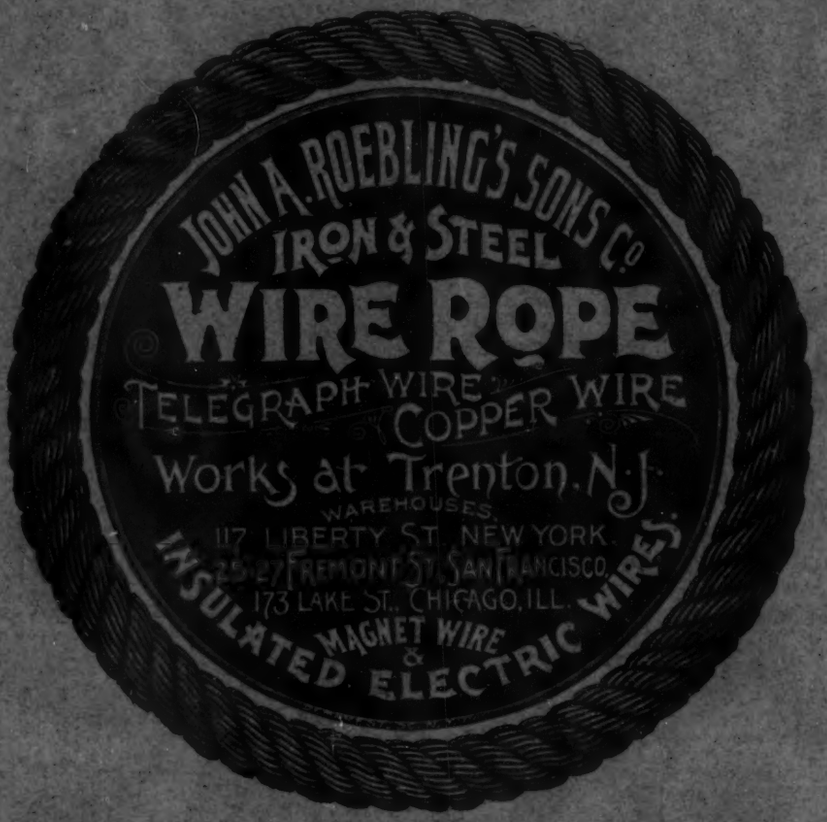

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The Journal of Electricity

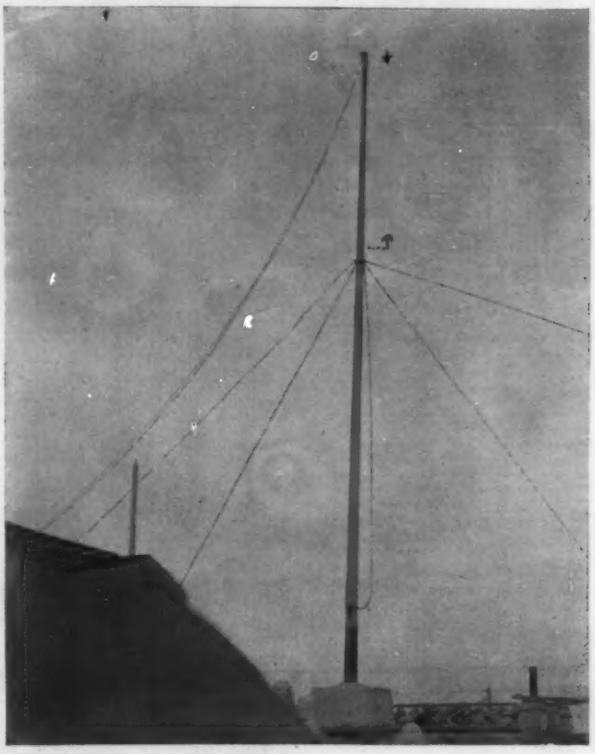
VOL. III. SEPTEMBER 1896. No. 3

Lightning in California.

By ALEX G. McADIE, Local Forecast Official.*

On one of the busiest corners of San Francisco, in the office of a large electrical company, there has been prominently displayed during the present summer a number of lightning arresters with placards calling attention to the principles of their construction and their probable efficiency. There are also some photographs of vicious-looking lightning flashes, which the writer was at no loss to recognize inasmuch as they were some he had himself made in the East. The fact that there should be such an exhibit is not without significance, because it has been generally believed that the Pacific Coast, or at least the southern half of it, was a region free from thunder-storms, and that damage by lightning was practically an unknown quantity. One is well within the bounds in saying that protection of life and property from danger by lightning has been hither- the total damage in the entire country west of the to considered a matter of no importance. It is true that Rocky Mountains is but a small fraction of the total damage done by lightning east of the mountains. But for any accurate comparison the density of population should be considered. In the East, damage by lightning occurs between the months of April and September; the maximum damage occurring in June. It may occasion some surprise to Californians to read that thunder-storms occur in California throughout the whole year. The records of the past year show that there was but one month free from thunder-storms.

The accompanying table, compiled chiefly from the records of the California State Weather Service, shows the distribution of thunder-storms in this State from July, 1895, to August, 1896. Doubtless there are many places not mentioned here where storms occurred. In all there are 356 reports. If we take the different dates we find that there were three dates in July on which storms occurred; six in August; eight in September; ten in October; none in November; three in December; five in January; two in February; three in March; nine



THE POINT LOBOS SIGNAL FLAG POLE.—SPLIT AS INDICATED BY THE ARROWS.

in April; fifteen in May, and six in June, twenty-two in July 1896, and seventeen in August, 1896.

There is a remarkable increase in the months last named. Some of the storms covered very large areas and were quite generally reported; such for example as Oct. 14-15, 1895; May 29, July 24 and August 28-29, 1896. I have found on examining some marine reports

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that on January 25, thunder-storms prevailed in the Pacific Ocean at 125 degrees and 155 degrees north latitude and probably in the region between. In fact it and it is therefore not surprising to find that a day or was a condition favorable for thunder-storm formation two later thunder-storms occurred throughout Californ-

few following notes will make plain:

On January 26 the plant of the Haywoods Electric Light Company was struck by lightning. The electrician, Mr. J. Putnam, is reported as saying: "I was not more than twenty feet away from the dynamo when the crash came, and it seemed as if the lightning filled

The Distribution of Thunderstorms in California.

STATION.	County.	1895							1896								
		Elevation.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	
Bodie	Mono	8248	16-21	12	20								22-23	22-23-24	4-5-21-23-25	12-17-18-19-22	19
Briggs	Yolo	51				14-15	15										3
Centreville	Alameda				8	14-15											3
Crafton	San Bernardino	1759								29					4	16	3
Crescent City	Del Norte	50						14	21	29		9	29			29	6
Durham	Butte	180						15					29			30	5
Descanso	San Diego	3400							29					13	9-10-12-13-24	14-15-27	3
Edmanton	Plumas	4750		26	17-18	15-16 19-20-21			17-26				28		5-15-16	22-28-30	10 17
Evergreen	Santa Clara	150											6				1
Follow's Camp	Los Angeles	800										10	6			16	3
Fort Bragg	Mendocino							20	18-26								3
Folsom City	Sacramento	182				20					27	24	6-21			22-30	7
Grass Valley	Nevada	2060							29	29		9-24	29			22-30	7
Greenville	Plumas	3600		26	17-28	15-20				29					5-15-24-25	22-23-24-28-29	15
Guinda	Yolo				13	14-15			26				28		5		6
Georgetown	El Dorado	2750									26						1
Iowa Hill	Placer	2825		27	18	19			17-29		26	24				29	8
LaPorte	Plumas	5000			18	19			17			18	28	25	5-15	23-28-29	11
LaGrange	Stanislaus	293			18												1
Lick Observatory	Santa Clara	4209				14-15							6				3
Lime Kiln	Tulare					18-19				29	25-26-27						6
Lodi	San Joaquin	32								29	27	26			25		4
Los Angeles	Los Angeles												7				2
Los Gatos	Santa Clara	83											28			19	2
McMullen	Fresno							15		18	26		8		3-4-7-12-17-24	20-30	12
Middletown	Lake	1300											22-23		29	29-30	5
Milton	Calaveras	650								29							1
Mokelumne Hill	Calaveras	1550											28-29				2
Mt. Glenwood	Santa Cruz					15											1
Napa	Napa	95				13-15-16						15					4
Newcastle	Placer	956										24				18-22	3
Niles	Alameda	87							26			15				19	3
North Bloomfield	Nevada	3300			18											22	2
Oleta	Amador	1510				13-18-19-20			29		26	24	28				8
Orangevale	Sacramento	300								29	27					22	3
Ontario	San Bernardino											9					1
Pasadena	Los Angeles	875			26-27												2
Paso Robles	San Luis Obispo	880											6		4		2
Peachland	Sonoma	200							26				6-29		10	19-20	6
Pichaco	San Diego								28						9-12-13-14-15 -18-24	14-19-26-27-28	13 10
Pilot Creek	Plumas												7-29		5-15-16-25-26	17-22-29	11
Placerville	El Dorado	18				15-16-17			29	29	26-27	16-21			25	22	
Quincy	Plumas	3350		26					17-21				28-29		15		2
Reedley	Fresno												6		4-5-22-24		5
Rio Vista	Solano	11											6		10		3
Roseville	Placer											16-24	8-9-18			21	2
Rosewood	Tehama	865				17-20				29		18-19	23	1-26	5-15-25,27-28	19-20-23-28-29-30	22
Sacramento	Sacramento	35				15							28			22	3
San Francisco						15			26			16-24	29				5
San Jose	Santa Clara					14							29			19	3
San Miguel Island	S. B	500				19											1
San Leandro	Alameda	48				15			26				29				3
Santa Clara	Santa Clara	83				14										20	2
Santa Cruz	Santa Cruz	25								29					22	18	3
Shasta	Shasta			19		17-20			28		26-27	18-21-29	2-3-23-28-3		17-26-27-28	20-27	20
Snedden's Ranch	Ventura								27			10					1
Summerdale	Mariposa											24					1
Susanville	Lassen	4195			17								8-21			19-23	3
Turlock	Stanislaus	106													4-25		3
Ukiah	Mendocino	620			17			20					6-21		10-29	22	7
Upper Soda Lake	Lake	1300											28-29		10-27-28-29		6
Ventura	Ventura	50							27							17	2
Washington	Nevada	2140										29			15		2
West Point	Calaveras											29			25		2
Wire Bridge	Placer	565										24			25	22	3
Yreka	Siskiyou	2635	3	28-29									23-29-31	1-2-30	25-26-27-28	19-20-21	16

nia. These storms apparently moved inland from the West.

There is another class of storms however, which does not find its origin over the ocean. These are storms which come from the southwest. Given a condition favorable for thunder-storms in the valley of the Colorado River in July and August, one may look for thunder showers within the following ten hours in the lower part of the San Joaquin Valley.

Whether lightning is dangerous in California the

the whole building. The flame shot out from the dynamo about eight feet and the wires, magnets and mica were thrown all over the place. I instantly ran to the switchboard and disconnected the wires and there was no more light that night. The accident was a very simple one and one that will be guarded against in future. The lightning was conducted to the machine by one of the wires, and of course the dynamo was instantly overcharged and burnt....There is one hole and no trace of the missing metal. The wires that sur-

round the magnets were so highly charged that they flew in all directions and when the mica was free it fell around in showers. It will take several days to fix the wrecked machine. If I had been oiling that dynamo when the lightning struck I should have been charred to a cinder as rapidly as that piece of iron was burned."

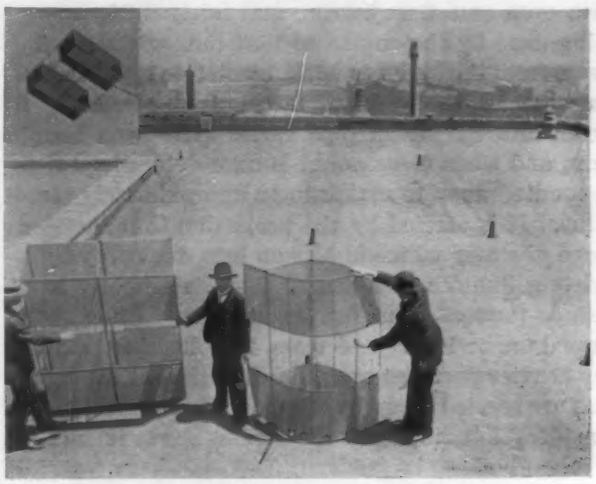
At Folsom, on the 24th of April, lightning struck the lines of the Electric Light and Power Company five times and the machines went out of step at each stroke. The lightning arresters were burned and discolored. On April 9th, at Ontario, two strokes of lightning entered the Electric Power House. Wires were burned and a coat belonging to one of the employees set on fire. "The first stroke, it is stated, came from overhead, while the second struck the wires miles away and came in when the sky was clear overhead. Lightning conductors were under the floor but had not been connected, as it was thought there would be no use for them. After the first stroke they were connected and occurred. Notwithstanding that much of it was grounded by the new conductor, it did more damage in the power house than the former, showing that it was much the heavier charge."

The Fresno Republican of October 17th, reports that: "A heavy thunder-storm in the hills caused the shutting down last evening of the entire electric plant of the San Joaquin Electric Company for twenty minutes. The lightning passing over the lightning arrest had just been made ready, when the second discharge ers caused the points to become welded together, forming a short circuit across the two lines. Occurring at a time when the city was in darkness the delay in repairing was greater than it would have been during the day. No great damage was done to the machinery."

In the city of San Francisco, houses and barns have been struck and some damage done. A large cypress tree on the southeast corner of Broderick and Green streets was riven from branch to root. A very large branch was torn off and thrown some little distance. On August 19th, this year, the signal flag pole at Point Lobos was struck by lightning and badly damaged. The pole was sixty feet high and the upper twenty feet were so torn that a new pole was necessary. Large splinters of wood were thrown over 150 feet away. Lights were burned out at the terminus of the Sutro Electric railroad and other damage done in the vicinity. In the light of what has happened, it would be unsafe to leave life and property unprotected by appropriate conductors and arresters. It may not be out of place to conclude this article with a few directions for procedure in cases of persons struck.

1. Make the stricken person breathe by artificially imitating the respiratory movements of the chest.
2. Keep the body warm.
3. Send for a physician.

Some very interesting experiments upon the electricity of the air at San Francisco have been made this summer by the U. S. Weather Bureau. With large kites Mr. Hammon and his associates have succeeded in getting marked electrical effects. These kites are for the most part of the Hargrave pattern and are flown by means of fine steel piano wire, from the roof of the Mills building, about 185 feet high. Altitudes of 4,100 feet have been reached. The roof has a covering of tar which probably makes a good insulator; for one can ordinarily stand and touch the wire without receiving



EXPERIMENTS IN ATMOSPHERIC ELECTRICITY.—KITES AND KITE-FLYING FROM THE MILLS BUILDING.

a shock. If one touches a wire leading to the ground and at the same time attempts to touch the kite wire, the charge is generally sufficient to shock one severely. On some occasions, when the sky has been covered with clouds, the electrification has been so strong that no one could touch the reel or wire until these had been grounded. With a condenser there is no difficulty even in clear weather, in getting large sparks.

It has been often shown that the potential of the air can be obtained through kites. At Blue Hill Observatory, near Boston, with tin-foiled kites, electrical condensers Thomson Mascart and multiple quadrant electrometers and hemp kite string wound with copper wire the writer made many experiments upon the electrification of the air. The most general points brought out were:

1. With increase of elevation of the kite, there was an increase in the potential.
2. The potentials were generally high, sometimes thousands of volts.
3. We could obtain sparks from a perfectly cloudless sky and often at an elevation not exceeding 500 metres.
4. During thunder-storms the phenomena are usually pronounced.

At San Francisco it has been demonstrated that the air was highly electrified, apparently just the same as along the Atlantic seaboard. There is no doubt that the upper air strata are untapped reservoirs of electrical energy. The current may be feeble but the potential is very high.

We hope to continue experiments in this direction.

Electro-Economics

SOME STATION ECONOMICS.

BY LIEUT. W. STUART-SMITH, U. S. N.

When boilers are working under normal conditions, with even and steady firing and fairly uniform work being done by the engine so that the withdrawal of steam from the boiler is not subjected to rapid and violent changes, the water of entrainment carried by the steam into the steam pipe varies little from hour to hour, and when the amount is once determined it can be counted upon to maintain an approximately steady value. It is carried by the projection into the steam space of water which is broken into fine spray by the twisting bubbles of steam as they rise rapidly to the surface (under considerable tension) after being formed on, and liberated from, the heating surface. The heavier particles at once fall back, but the lighter ones are carried along by the current of steam, in very considerable amount if the steam space is small or if the boiler is making steam very rapidly, and in lesser amount with slow steaming and ample drying space, the exact amount depending upon the design of the boiler and the method of working. In all cases it is present in the steam which flows towards the cylinder, and as the distance from the boiler is increased the amount of moisture carried by the steam is augmented by the water of condensation which is constantly produced in the pipe, the amount being a function of the temperature difference between the steam and the external air and of the surface exposed to the air, the nature of the surface determining the radiation and consequent loss of heat by the steam. The water thus carried is detrimental from three causes; its temperature is the same as that of the steam, say 300 deg. to 350 deg. F., and the heat required to raise it to this temperature from the temperature of the feed water is entirely wasted; its pressure greatly reduces the elasticity of the steam and consequently lessens the amount of work the steam would be capable of doing if it were dry; it enhances the reduction of temperature of the cylinder walls during expansion owing to the large amount of water which lies against the walls and is evaporated as the pressure falls towards the end of the stroke, the reduced temperature of the walls causing a considerably greater amount of incoming steam to be condensed than would be the case if the steam were originally dry.

Owing to the causes enumerated, wet steam may occasion a very considerable unnecessary expenditure of fuel and as many plants are working very close to the dividing line between profit and loss and the managers give little concern to the small economics because they know nothing about them, it is well to call attention from time to time, to things which every station operator should know. Obviously the best cure for the disease caused by wet steam is to prevent, as far as possible, the steam becoming wet. It is impossible entirely to prevent any water of entrainment being carried forward by the steam, but it may be reduced to a very small amount by; (1) ample steam room in the boiler or drum so that the velocity of flow of steam will be very small before it enters the pipe; (2) ample water surface so that steam need not enter the steam space in the form of large bubbles, such bubbles being under considerable tension and bursting with considerale force as they reach the surface, breaking the water into fine spray and throwing it into the steam where it is held in suspension and passes with the steam into the pipe; (3) heating surface from which the small steam bubbles are easily detached as fast as formed, if this cannot occur large bubbles will be produced which must attain very considerable tension before they can liberate themselves; (4) free and rapid circulation so that the water in all parts of the boiler will be as nearly as possible at the same temperature and the water currents will sweep the small steam bubbles from the heating surface and thus prevent the formation of large and explosive ones. All these points are embodied in the design of every good boiler and can be obtained by exercising judicious care in purchasing. To purchase a boiler of poor design because it is cheaper in first cost is the most expensive economy. No particular type has a monopoly of these good points as they may be found to an equal extent in return tubular, locomotive tubular (sectional or otherwise) or combinations of these.

Condensation in the steam pipe cannot be entirely obviated but it can be very much reduced by taking proper precautions. Obviously the pipe should be as short as possible as this reduces the surface from which heat can be radiated; also vertical sections should be avoided to as great an extent as possible as the volume of air sweeping over a given length of vertical pipe is much greater than that over an equal carried away is greater and the condensation is in direct proportion to the heat wasted.

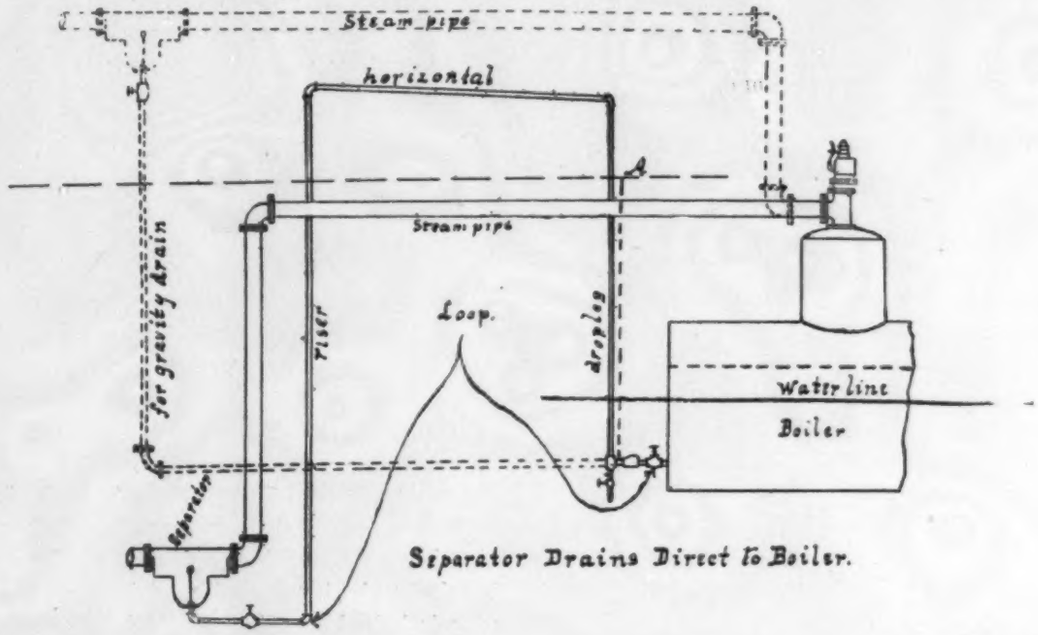
Covering the pipes to prevent radiation is a common practice which should always be followed. Care should be used in selecting a covering, the idea that anything which will not burn is good enough being a fallacy. Some so-called non-conducting coverings permit a waste of three or four times as much heat as others which will cost but a few dollars more to apply.

When the best of care has been taken to reduce the moisture in the steam to a minimum there still remains a considerable amount which should be removed if the highest economy of the steam entering the cylinder is to be obtained. For this purpose a good separator should be placed as close to the cylinder as convenient. There are several of these on the market

which are highly efficient and, if properly installed and managed, will pass to the cylinder practically dry steam. The management of these consists mainly in keeping them well drained, as it is found by experience that if the water in the reservoir is allowed to rise above a certain height the steam sweeping over the surface will carry the water with it and no further separation will take place. Though a drain cock is an integral part of every separator and a glass gauge is (or should be) fitted for showing the height of water in the reservoir, reports constantly come from sections that the steam is very wet even when a good separator is of the trouble required for replacing. Usually, however, they are kept properly drained, the pipe leading to a trap and thence to the hot well from which the fitted and examination frequently shows that the gauge glass has been removed as a useless appendage or, having been broken, has been thought unworthy water is taken by feed pump and returned to the boiler.

The accompanying sketch shows two methods of direct draining to the boiler. The dotted lines show the steam pipe, separator and drain pipe arranged for gravity drain. This can be accomplished whenever the lower part of the separator is at a distance above the water level of the boiler greater than the height of a column of water which will balance the difference of steam pressure at separator and boiler. This is indicated by the dotted line at "A." If the separator is not above this line an attempt to drain by gravity would result in flooding the separator and possibly the cylinder. A steam gauge applied to separator will show the drop and a simple calculation will indicate whether gravity drain can be adopted in any particular case.

The full line drawing shows a simple device for direct drain whenever the separator is below the level of the dotted "A." This device is called a "steam loop" and deserves to be much more widely known



Separator Drains Direct to Boiler.

This is good practice as far as furnishing by steam is concerned but neglects one of the small economics, the summation of which frequently determines the financial success or failure of a station. The quantity of water constantly passing through a separator is frequently of very considerable amount and while it is in the separator and in contact with the steam it has practically the temperature of the steam, say, on an average 330 deg. F. After it leaves the separator, mixes with other water, and is exposed for a time to the air the temperature falls to say, 190 deg. F., at which temperature it is admitted to the boiler. This is a loss of 140 thermal units per pound of water, aggregating for a day's run, many pounds of coal burned which would be saved if the water was returned to the boiler at a temperature but little below that which it has in the separator. As this direct return is readily accomplished there is no excuse for the waste.

than seems to be the case. Its function is to produce an artificial head in virtue of which the water collected in the separator may be returned to the boiler against the difference of pressures existing in the separator and boiler. The sketch shows the elements of the device and the principle of its action is readily explained. From the bottom of the separator a pipe called the riser extends to an elevation somewhat greater than the height of a column of water, equaling the pressure difference between separator and boiler, this pipe may be vertical or part vertical and part horizontal as may be convenient, the essential feature being that the upper end must be at the height indicated; from this upper end a pipe called the horizontal leads away towards the boiler and has sufficient slope to cause any water which may enter it to flow towards the boiler; the horizontal terminates in the drop by which, as is the case with the riser, may have any direction so long

as it is generally downward; it terminates in a connection to the boiler below water line.

The action is as follows: With a difference of pressure between the separator and the boiler, if the stop valves at the separator and the boiler are opened, water rises in the drop by to the point "A," when the water column balances the pressure difference and the system is in equilibrium with no tendency to motion in any direction. The drop leg and riser are clothed with a good non-conducting covering, but the horizontal is uncovered so as to permit free condensation of steam within it; under these circumstances rapid condensation takes place with the result that the equilibrium previously existing is destroyed and the pressure in the horizontal is less than in other parts of the system. The contents of both drop leg and riser rush upward in an attempt to restore the equilibrium, but the contents of the drop leg is water while the riser isfilled with a mixture of steam and watery spray many times lighter than the water in the drop leg. The result is that the contents of the riser will pass into the horizontal when the water will separate from the steam and, by virtue of the downward slope of the horizontal, will flow into the drop leg and thence by gravity into the boiler. As condensation is continually taking place in the horizontal, steam from the separator is continually passing upward through the riser, sweeping with it the water which enters the separator and preventing any accumulation. The action is absolutely continuous and once started will work continuously with no attention whatever, returning to the boiler all water of entrainment and condensation with but a trifling lowering of temperature. As the water is lifted against a head equal to the difference between pressure in the boiler and that in the separator work is done, the necessary energy being obtained from the steam which is condensed in the horizontal. To start the loop, steam must be blown through it to remove the air and supply steam for condensation in the horizontal.

Under ordinary conditions the water collected by any separator should be comparatively steady in amount but experience shows that very considerable quantities of water of primage can be readly handled by the loop. A primage is very erratic, however, and frequently causes large quantities of water to pass into the steam pipe, a large waste drain with valve should be fitted to the separator in order that such erratic flow of water can be quickly disposed of.

Primage is usually said to be incapable of being properly accounted for, but in land boilers supplied with an unvarying quality of water, there is little excuse for it and when it occurs it may be put down as the result of carlessness and inattention. Either the boilers are very unevenly fitted and one is required to guarantee steam at an abnormally rapid rate or else the water has been allowed to become very dirty and greasy. In marine practice passing from salt water to fresh, or vice versa, as when passing into or out of a river will frequently cause violent priming if deficiency of feed is made up from the water in which the vessel is steaming. When it frequently occurs in land practice, a new fireman will probably prove the best panacea.

A source of considerable fuel waste in many stations is insufficient diameter of steam or exhaust pipes, or both. With a high speed non-condensing engine, too small an exhaust is common. Cases are frequently seen in which the expansion, exhaust, back pressure, compression and admission lines are excellent but in which the steam line falls towards the point of cut-off at a very considerable slope. Such a card invariably shows too small steam passage somewhere between the boiler and the cylinder and if it is not locally choked it is certain that the steam pipe is too small. A pipe which is of ample diameter for a short lead may cause a very heavy drop if the engine is at a considerable distance from the boiler.

With a high speed, non-condensing, engine the exhaust pipe is long and as the steam must be very quickly discharged under a small pressure difference between the cylinder and the atmosphere, the pipe should have much larger capacity then would be necessary with short exhaust to a condenser. Cards are frequently seen in which the back pressure line quickly rises three or four pounds as the piston gains headway after the crank passes the center, a difference of pressure which represents several horse-power. When an engine gives such cards the pipe should be very much enlarged and shortened if possible.

Another fruitful source of waste is an idea, which is prevalent among station managers, that a Corliss engine has no equal for any purpose. The writer has in mind a plant near San Francisco where a Corliss engine is belted to a jack shaft from which are belted two machines which could be direct belted from the two wheels of a high speed engine at a saving of several per cent in power. The manager had been a small bookkeeper before becoming manager, but he very soon learned all that in his estimation was to be known about an engine. Similar arrangements are common.

Oil is sometimes wasted. A station not far from San Francisco ran for several years with an oil expenditure of fifty dollars per month. A competent station man took charge of the overhauling of the plant and with the same engines and dynamos the oil expenditure was reduced to seven dollars per month.

It would pay many a station manager to have proper examination made of the small economies which seem too trifling to bother about or about which he knows nothing.

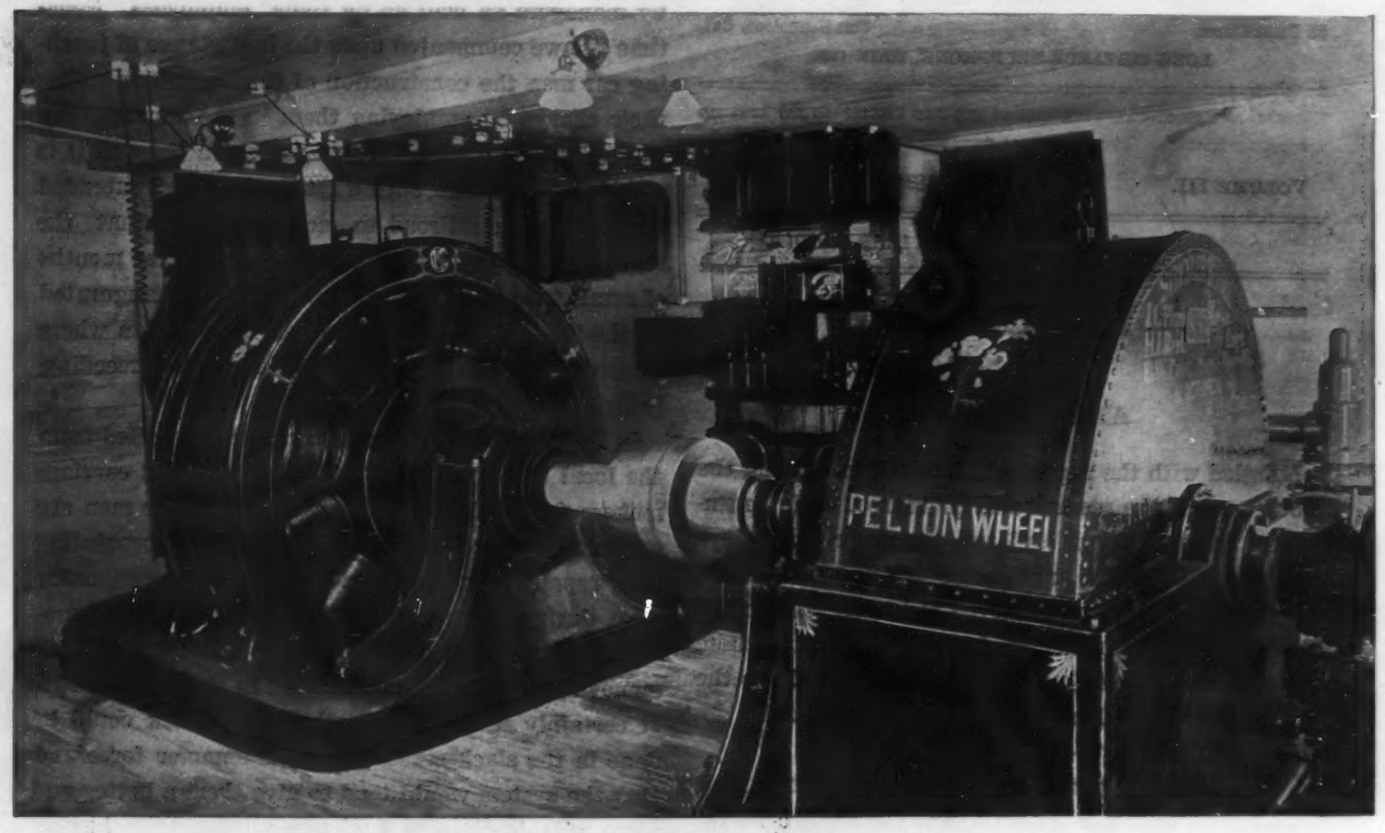
THE MANITOU TUNNEL POWER PLANT.

The station of the Manitou Tunnel Power Plant is located a short distance above the Iron Springs Hotel, at Manitou, Colorado, and consists of a 500 h. p. Pelton Wheel direct connected to a General Electric Company's generator. The wheel runs under a head of 600 feet and is speeded at 600 revolutions per minute.

The power thus generated is carried a distance of 8 miles and runs an air compressor for supplying the drills operating in what is known as the Strickler Tunnel, which is being driven through a spur of Pike's Peak range. This tunnel is 6,400 feet long and forms a part of the new Water Works system of Colorado Springs. Operations on the tunnel are carried on from both ends, and light as well as power is supplied from the station for the power house as well as all underground work.

This is believed to be the first instance in which the brought to bear upon a project of this character. The facility it has afforded for the rapid and economical prosecution of the work has been a gratifying surprise to all interested in the enterprise.

The 13-inch drain supplying Colorado Springs carries a pressure at the reservoir of 170 lbs., which it is now proposed to utilize, by means of Pelton wheels tand electric generators, for lighting the city.



THE MANITOU TUNNEL POWER PLANT.

NEW STEAM SPECIALTIES.

Among the new agencies recently awarded to the H. N. Cook Belting Company of San Francisco for steam specialties is one worthy of special consideration, namely, the "P. P. P. Diagonal Rod Packing," manufactured by Charles A. Daniels of Philadelphia. In this packing one side is an absorbent cushion for oils, which keeps the rod well lubricated and prevents the danger of breaking the gland or putting undue friction on the rod. The other side is composed of the best materials for wear in the stuffing-box and is made in wedge shapes, which, under pressure from the glands, slide on each other, thereby compensating for the wear made by the rod.

It is claimed that this is a perfect rod packing, as it is the most elastic packing under all conditions, and by its use is obtained the minimum amount of friction and the minimum amount of wear. It is impervious to the action of steam, oils, acids, alkalies and sulphurous waters, and is a perfect preventive against the loss of ammonia in the ice machine. It works equally well on the heavy mining pumps and the most sensitive valve stems. On the steam hammer there is no indication of "drip" and it is not affected by the vibration of the rod. It is the only packing that is an absorbent of the lubricants, insuring a film of oil on the wearing surface and adapting itself to all conditions of the rod, and all inequalities of the stuffing-box and is equally adapted for the hydraulic elevator or the air pump. It is more pliable, hence more quickly and easily applied than any other. It is the most economical, requiring less frequent packing—none is thrown away, but simply a round is added when needed. Less steam used—or allowing a greater number of stokes per minute with same pressure; it may be run by tightening glands with fingers only. It works equally well running at high or low pressure.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY
F. A. C. PERRINE, D. Sc., and GEORGE P. LOW.

H. A. HEYWOOD - - - - Business Manager

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EDITORIAL.

ANNOUNCEMENT.

Mingled with the regret which is felt in craving the indulgence of the readers and patrons of "The Journal" for the lateness of its issue, the proprietor enjoys great satisfaction in announcing the appointment of Mr. H. A. Heywood as Business Manager, who, in assuming the new position, renders it possible to reclaim promptness and easily advance "The Journal" to the high plain of excellence to which it has aspired.

THE VALUE OF ASSOCIATION.

Notices in the current electrical papers of meetings of the Electro-Therapeutic Society in New York call to mind the fact that the existence of an association for mutual action and the exchange of ideas throughout the country, mark the rise from local interest to wide application in any industry. All who are engaged in any common line of work find that their own interests are furthered rather than prejudiced by helping their fellows and receiving help from their co-workers. It is only when the man of business is small that extreme distrust of neighbors is felt. With increase in power, increase in knowledge is required and at the same time, jealousy is removed. Applying these principles to the condition of the electrical industries of the Pacific Coast makes us again convinced that the time has come for the establishment of an association for mutual help and protection.

EMPLOYMENT THE YEAR THROUGH.

With the approach of winter many electric railroads are operating a smaller number of cars and laying off many motormen and conductors who were engaged for handling the summer excursion business. That this should be necessary seems to be a great disadvantage to any company, and we believe that a proposal which will reduce the necessity of such action would be approved by managers as well as by their employees. Some time ago we commented upon the importance of teaching car men the construction of the machinery under their charge by employing them in the repair shop during the time they were on the extra list and it is pleasing to find that such a system has been extended by any electric railroad to such an extent that the force does not become disorganized during the months of small travel. Such a system has been inaugurated by the Tramways Company of the Isle of Man where a heavy summer travel is succeeded by an exceedingly light winter load.

In that island the car men have been recruited from the local blacksmiths, painters, cabinte and carriage makers and during the winter months these men are employed in renovating the entire plant, repainting cars, repairing motors, etc. Many power companies have, during recent years, rebuilt cars, rewound motors and done their own repairs and have saved much money by doing work of this kind in their own shops. It certainly seems that much of this work could be done in the slack season with the summer force and that the system would tend to give them a better and more reliable class of workmen all through; having their employer's interests well at heart, besides effecting much saving in the general management of the company.

THE RATING OF ELECTRICAL MACHINERY.

Having occasion a short time ago to examine the efficiency curves of a set of motors furnished by one of the large manufacturing companies, we were struck by the fact that these motors were rated at from 25 per cent to 50 per cent beyond their load of maximum efficiency, a practice differing decidedly from the established custom of steam engineering where the power of engines are invariably rated at the load of maximum efficiency. This high rating for electrical machinery

seems to be a survival of the time when the heating of a machine alone was considered as limiting its power and when efficiencies were rarely considered and still more rarely measured, indeed, a few years ago it was found by the operators of electric reduction and aluminium plants that no machines manufactured in this country were capable of operating at their rated loads for 24 hours without overheating, and in consequence these ratings seem to give neither their maximum capacity for continuous service nor the maximum capacity for efficient service, but rather represent the loads that can be carried for a short period of time, or in other words the capacities which must not be exceeded under any circumstances. This fact is very confusing to the central station designer who endeavors to install machinery in such a manner that it will give the best possible continuous station efficiency, for no matter how well designed and chosen the specified size of machine as taken from data at hand, there is no guarantee that in an open competition machines will not be purchased which will not be operated at much different efficiencies from those intended in the design, and in consequence the present practice has the effect of a handicap upon careful designing. If it is necessary for machines to be sold on the basis of their greatest possible output, should not also the most efficient load be stated by the manufacturer and a careful engineer given the opportunity of applying his ability in the choice of machinery to give a high average efficiency under a particular system of operation.

DISREPUTABLE PATENT COMPETITIONS.

We have recently received a copy of a paper called the "National Recorder," issued by a firm of Washington patent attorneys claiming that a million copies of their journal are regularly printed and who offer monthly medals and prizes for especial ability in invention, to inventors taking out patents through their agency. This is one of the many "catch-penny" devices bringing discredit upon the patent system of this country. In the heat of securing prize money, young men and mechanics are induced to take out patents upon unsalable inventions, squandering money and time to the ultimate benefit of no one except the patent attorneys. Perhaps for sale abroad such a medal may give an undue importance to a trivial invention, but we cannot see any way in which such a system can be of advantage in legitimate business. No one who has ever patented an invention has failed to receive from one or more companies very flattering letters concerning the value of his invention and its patentability abroad with the offer of a medal or a diploma for a small fee, though the fee is always much greater than the value of the medal received and there is no intent on the part of the grantor of the medal beyond the deception of the unfortunate patentee who may be allured by their flattery. There are in France and in this country respectable patent competitions whose medals attest the excellence of inventions, but these competitions are not administered for the purpose of inducing applications for patents through particular firms, but are offered by such institutions as the Franklin Institute and the French Institute for the encouragement of national industry. These legitimate prizes are not fictitiously offered and their awards have real value while such schemes as those presented by the firm in question can only have the effect of increasing the number of useless patents and of bringing discredit on the whole system of issuing patents.

FINANCE AND ELECTRICAL INDUSTRY.

It is not often that we find technical papers indulging in political discussions which may be explained from the fact that their business connections are too complicated to allow them to become exponents of one or another shade of political opinion but, during the present campaign, we find that the electrical newspapers either consider that their constituencies are all of one mind or that the questions involved are of too great importance to allow personal advantage to interfere with the patriotism of the editors. By whatever reasoning we may explain the fact (and personally we believe the last to be the true state of the case) no one of the electrical papers coming to our table has hesitated to express its opinion on the financial planks of the two contending parties, and what is yet more remarkable, we find that they are unanimous in condemning the free silver platform announced by the Chicago Democratic Convention. These papers are the mouthpiece of an industry which while being one of the largest and most widely diffused in the country is administered by the most highly educated men at present employed in any trade. Furthermore, the electrical undertakings throughout the United States are heavy borrowers of money, both at home and abroad and one would perhaps expect that such borrowers might find some satisfaction in repudiating

part of their indebtedness; the practical effect of free coinage of silver.

In spite of this partial advantage to certain companies we do not find and commendation of the scheme proposed for the free coinage of silver. To be sure in many cases bonds have been placed by electrical undertakings which are payable in gold and where this is a fact, nothing but disaster could follow the introduction of a cheap dollar. Perhaps their bills for wages and coal could be met as well under the new basis as under the old though their proportionate interest charges, which now amount to from 10 per cent to 20 per cent of their entire expense, would be immediately doubled. Indeed, it seems impossible to us to understand how business men can reasonably endure this proposed solution of the financial difficulties in this country whether they consider their own integrity or their own personal advantage. Should it be possible to immediately obliterate and start anew all business undertakings, the existence of a cheaper money would not necessarily prove a hardship; but no such revolution is possible; the future must be faced with past obligations in full view and integrity would demand that money which has been borrowed without stipulation should be paid without depreciation. Where money has been borrowed payable in gold such a payment must come from the earnings, and if the value of the net earnings in terms of gold is depreciated the time of possible repayment is correspondingly lengthened. We hope that these facts are already sufficiently apparent to manufacturers of every kind and at the same time trust that those engaged in manufacturing will feel a personal interest in the credit and personal integrity of the community at large which will turn the tide on election day in favor of a system which will not disturb but which will strengthen the national credit.

Mr. Harvey L. Lufkin, the genial manager for the Cocker-Wheeler Electric Company of New York, and who has been intimately associated with the leading electric motor interests of the country from the incipiency of the industry, is in San Francisco with headquarters at the offices of the Pacific Coast managers for his company, the Abner Doble Company.

Mr. G. F. Kutz, after many years service in the Navy, has resigned from the engineering staff at Mare Island to enter the employ of Messrs. Chas. C. Moore & Co., upon whom the employment of so eminent an engineer reflects great credit.

Passing Comment

An Editorial Review of Current Events and Comtemporary Publications.

THE INACCURACIES IN JOURNALISM.

We have from time to time noticed errors made in electrical papers and have regretted that such errors should show either carelessness or ignorance on the part of the editors, but we do not remember having seen so surprising a piece of misinformation as that contained in the "Electrical Age" for September 25th, where under the heading "Spectrum of Sodium" it is stated on the authority of Professor Peck that "if a piece of lime be rendered incandescent by heating it in an oxo-hydrogen flame, its light, when transmitted through a prism gives a perfectly continous spectrum." Anyone familiar with elementary chemistry would know that lime is carbonate of calcium and not a compound of sodium, while no one familiar with spectrum analysis would expect to get a spectrum of a material from an incandescent solid, all such bodies giving continuous spectra whatever their material. Spectra of the metals can only be obtained from vapors and the spectrum of sodium consists of two yellow lines well known as the "D" lines. Such pieces of careless editing are of course ridiculous to the educated but are exceedingly misleading to many readers of the journals who look to their papers as a means of obtaining knowledge and information for which their education has not been sufficiently extensive.

ELECTRICITY IN THE NEW NAVY.

In the issue of the "Electrical World" for August 16th is an elaborate description of the electric machinery used in operating the various signalling and maneuvering systems of the battleship "Indiana." The article is particularly interesting to engineers as exemplifying the many uses which can be made of the electrical current, from measuring the angle in the Fiske Range Finder, steering the ship by an automatic electric compass, to loading, training, and firing the heavy guns. Indeed the electrical engineering training necessary to keep the apparatus of such a ship in order includes as many details as would be necessary for an engineer controlling the operations of an entire city. While we are compelled to admire the ingenuity displayed in the invention of this apparatus, we are also impelled to wonder at the possible effects on such machinery when receiving the severe shocks incident to a combat. Considering the weight and velocity of a solid shot thrown by one of the high power twelve-inch coast defence guns, we can say that, should the "Indiana" be struck fairly astern, enough energy would be delivered to the ship to propel the vessel at full speed for a distance of four hundred feet, and apart from the possibilities of penetra-

tion and explosion of shells such mechanical shocks would certainly test very severely every piece of delicate mechanism on board the vessel. Indeed, during the late Chinese war one of their ships was several times plunged into complete darkness by a failure of their electric machinery due to the severe shocks received by the vessel, and unless the mechanical details are so well worked out in the vessels of our navy that these delicate machines will withstand the most severe mechanical shocks, our floating fighting machines in time of battle would soon be reduced to floating shelters without offensive power. There is no doubt but that electrical power for manipulation is more easily adapted to the requirements of such a ship than steam or hydraulic power, and the question we would bring up is rather concerning the necessity of the efficiency of the machinery as such. These questions of course can receive no further light until the dreaded test is made and until such a test is made perhaps the ships are serving their purpose by giving employment to men and in offering opportunities for the exercise of ingenuity.

ELECTRO-ECONOMICS IN STATION PRACTICE.

In the English "Electrician" of August 21st, Mr. Arthur Wright of Brighton, England, presents an interesting paper on central station practice in which he shows the law of variation between the cost per unit and the rate of supply in such an undertaking. Carefully analyzing this cost Mr. Wright shows that the cost per unit follows a curve which varies from month to month as the maximum supply of the station rather than the curve of daily average supply, from which it appears that the cost per unit of any electrical supply contains constants depending on the maximum monthly output which are of more importance than the consumption of fuel and the cost of other quantities variable with the continuous output. This indicates that for great economy the central station engineer should determine these constants and apply his ingenuity to reducing their value and not devote himself entirely to the question of coal consumption which at present is so largely considered to the exclusion of all other details. The discussion also shows that the effort to increase the average load to a maximum value is an effort in the right direction and where an engineer is able to bring this about he is also working towards a high efficiency. Such efforts towards economy which involve a corresponding increase in station equipment for the storage of energy have not been attended with a great deal of success, and one would hope to find a future increase of economy from a reduction of the constants we have mentioned rather than along efforts to level out the load line.

INTERNATIONAL BIMETALISM.

Whether or not the efforts to remonetize silver shall eventually prove to be of benefit or harm to the financial situation, there certainly seems to have been no plan proposed for remonetization as comprehensive and business like as that proposed by Richard Rothwell in the "Engineering and Mining Journal" for Dec. 3rd 1892 and recently republished in a pamphlet entitled "International Bimetalism". Mr. Rothwell proceeds as one desirous of preserving the great silver industry and in the first place shows that the manufacturing demand for silver at a price no higher than 20 cents per ounce would be supplied for a long time to come by the the stock at present on hand in the mints of the world and he accordingly concludes that as the mining cost for silver amounts to no less than 68 cents per ounce any attempt to reduce silver to the condition of a material for the arts would be naturally disastrous to the industry. In consequence therefore we are faced by the condition that a great industry exists which can only be made useful by the continued employment of silver as a currency. This conclusion is drawn in the face of his opinion that it would require a long period of depression and financial panic infinitely more intense than any ever yet seen, and many bitter strikes accompanied by struggle and desperation and a general stoppage of the wheels of commerce before the business of the world could be adapted to the new conditions, and men would willingly accept half or one-third of the wages they had been accustomed to." This opinion he makes the basis for an argument, which seems unanswerable, against universal monometallism with gold as the only money as well as against the single adoption by the United States of the free coinage of silver. Furthermore he judges that the unlimited coinage of both gold and silver by all the mints of the world upon a fixed ratio could not prevent a continual variation in the standard of value resulting in alternating monometallism, now of gold and now of silver. In order therefore to solve the vexed problem and preserve in justice and an intelligent consideration for the interests of the human race, he makes a proposal that an international clearing house be established which shall govern the unlimited coinage of gold and silver upon a ratio occasionally variable with the variations in the money values of the metals. That such a system would not result in excessive fluctuations in the values of the coins he shows by a comparison of the value ratios of gold and silver and the world's producing ratios from A. D., 1500 up to the present time; the first remaining nearly constant in spite of the tremendous fluctuations in the latter.

No man in the country has the interest of the silver producer more at heart than has Mr. Rothwell, and few are more capable of speaking concerning our mineral industries and business interests than this man; we must therefore receive his conclusions with due respect and carefully weigh his results. If there is a fallacy in his reasoning it seems rather to lie in the increasing disuse of coin rather than in any impracti-

cability of his plan for universal bimetallism at the present time only between 5 per cent or 10 per cent of this country's business involves the use of coin and should we have the introduction of a universal clearing house, international credit transfers would be increased and international coin transfers diminished. Furthermore, any such wide extension of the clearing house principle might work down as well as up and the use of coin in small transactions be diminished by the establishment of many local and interstate clearing houses handling small debts and credits as an international clearing house would handle public accounts, resulting in an extension of the principle of barter and a vast diminution of the demands for coin in all lands. Whether the countries of the world must take account of the existence of a great mineral industry and strive to maintain its importance, or whether the mineral industries must recognize the changed position of the metals as money, remains for future solution, though we must grant that one or both of these conditions are demanding to be met and the present financial operations to be revolutionized.

A MAMMOTH WATER-WHEEL.

The Pelton Water-Wheel Company has recently furnished the Alaska Gold Mining Company, of Douglass Island, Alaska, a wheel of such extraordinary dimensions as to make a brief description of interest.

The wheel is 22 feet in diameter and is direct connected to the shaft of a Reidler Duplex Compressor, with air cylinders 24 in. in diameter x 38 in. stroke, having a capacity of delivering 2,800 cubic feet of free air per minute at a pressure of 80 lbs. per square inch. The wheel weighs 25,000 pounds, and serves the purpose of a fly wheel as well as prime mover. It runs under a water head of 480 feet at a speed of 75 revolutions and develops upward of 500 h. p. A hydraulic speed regulator is attached to the wheel, which controls its movement so that a uniform air pressure is maintained on the receiver. The wheel is made of this large diameter to give proper speed to the compressor under the head in this case available.

This is probably the largest tangential wheel ever constructed and shows the remarkable facility with which Pelton wheels can be adapted to unusual and extraordinary conditions. In a case like this the transmission machinery to carry such an amount of power would involve a heavy out-lay as well as constant expese in maintenance, besides a material loss of power; a direct connection to water wheel of machinery operated without intermediate gearing is, therefore, of great advantage wherever possible.

Mr. S. Z. Witchall, Manager of the Portland, Or., office of the General Electric Company, was a recent welcome visitor to San Francisco.

THE SMITH-MANIFOLD CALCULATOR.

BY GEO. P LOW.

The convenience of the slide rule as a time and labor-saving device has long been appreciated by all branches of engineering professions, and considering the wonderful facility with which intricate problems are solved thereby it is little short of astounding that the appliance has not come into universal use by every one who has aught to do with mathematical calculations, regardless of whether the problem to be solved consists of simply multiplication or division, of proportion, of calculations embodying logarithmic functions, of the conversion of units of measure, of geometrical or trigonometrical functions, or in brief, of effecting the solution at a glance of any problem based on the fundamental principles of proportion. The Brown & Sharp gauge for measuring wires is essentially a purely scientific one in that under it the dimensions of wires advance in geometrical progression, and in this connection it is interesting to review a portion of one of a series of articles by Frederic A. C. Perrine, D. Sc. on "The Manufacture of Wire" now running in Electrical Engineering, in which the author points out that "The sizes of different conductors may be distinguished by reference either to the measurement of their diameters expressed in mils, in fractions of an inch, or in millimeters, but the custom of wire manufacturers has rendered the distinction of wire sizes by reference to certain gauge numbers much more common. These gauge numbers are all more or less arbitrary and are a relic of the time when the correct measurement of a wire diameter was not readily made and when wire drawing was performed with great lack of uniformity. In order to compare various wires recourse was had to gauges of different forms upon which numbers were stamped corresponding to different sizes determined arbitrarily, and as the business has been developed the old gauge numbers have been expressed in decimals of an inch or in millimeters, and certain new gauge numbers have been adopted in which the variation in sizes of the different wires follow particular laws. The gauges above referred to were, in the earliest practice, plates of metal through which holes had been bored corresponding to the different sizes of wires. Many disadvantages attach themselves to this method of gauging. In the first place, it is necessary to square the end of the wire before determining its size; secondly, any irregularities in cutting off the wire would lead to false results in gauging, and finally it is impossible to tell whether the wire is closely or only roughly a fit into its particular hole. The first advance upon this method was made by the introduction of a gauge formed of a circular plate of metal with slots corresponding to the different gauge numbers sawn into its edge. This gauge was capable of being

used upon any part of the wire and of determining with greater accuracy the variation of the wire from its true gauge number.

"In about 1850 a new gauge was introduced which gave not only the gauge number, but with a reasonable approximation the variation of any particular wire from its gauge number. This gauge consisted of two straight edges of metal clamped together in such a manner that an open "V" was inclosed by their straight edges, and along the sides of one or both of these edges straight lines were stamped corresponding to the different gauge numbers. In use the wire of which one wished to determine the size was slipped into the "V" until it firmly touched both sides, when the nearest line would determine its size, and the distance from that line would determine the variation from the true gauge number. Although these different gauges have been manufactured from time to time most carefully of hardened steel and ground with great accuracy they were subject to variations in size produced by changes of temperature, and were especially liable to wear when frequently used upon a particular size of wire, thus introducing considerable confusion when wires were ordered to correspond to one instrument and manufactured from another, though both may have been identical when they were originally constructed. In consequence change has been proved throughout its continued use, especially for the users of electrical conductors, in which service the carrying capacity of the wire varying as the area is the most important point to be determined. A new gauge is now adopted as the standard in England and is called the English legal standard or Imperial wire gauge. This gauge differs from the American, or B. & S. gauge, in not determining the gauge numbers from areas, but in merely being a correction of the Birmingham gauge in such a manner that the variation in the size of the various numbers proceeds uniformly.

"Of recent attempts to change the system of numbering wire gauges the most notable is that adopted some years ago by the Edison Company, in which the gauge numbers refer to the areas of the wires in circular mils, the different numbers representing even thousands of circular mils; the system embodying very considerable advantages with the sole disadvantage that its identification with one company has hindered its general introduction. At the present time there seems to be no reason for desiring any change from the common system used in the determination of wire sizes unless it would be possible to eliminate altogether the Birmingham wire gauge from use and to introduce in this country both for iron and copper wires the more rational American gauge which is the standard for the users of electrical conductors who are by far the largest purchasers of wire at the present time. This wire gauge begins with No. 0000, having a size of 460 mils, and ends with No. 40, 3.14 mils in diameter. Larger conductors than this No. 0000, as we have already said, cannot readily be manufactured or handled, and in consequence the sizes of conductors with a greater area are generally expressed by their areas in circular mils and are almost always built up of smaller wires twisted into the form of a strand. In order to determine the size of the wire for forming any strand of a particular number of wires it is necessary only to divide the area of the strand by the number of wires, which will give the area of the constituent wires of the strand in circular mils, and the extraction of the square root will determine the diameter of the wires in mils; and conversely, the area of a strand in circular mils may be found by multiplying the square of the diameter of its constituent wires, expressed in mils, by the number of wires in the strand."

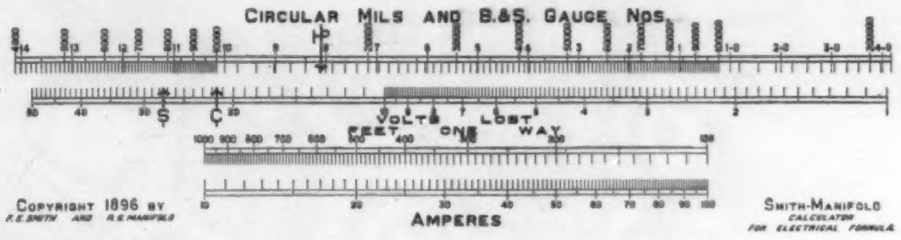

FIGURE 1.—THE SMITH-MANIFOLD CALCULATOR.

With these preliminary remarks on wire gauges it is well to proceed to the consideration of the Smith-Manifold Slide Rule Calculator for electrical formulae, which, as appears from the accompanying illustrations, is merely a slide rule on which is set off the characteristics pertaining to the area of the various sizes of wires in the Brown & Sharp gauge from No. 14 to No. 0000, together with the functions of an electric circuit as based upon Ohm's law. To faciliate an understanding of the slide rule in Figure 1 is presented an outline of the Smith-Manifold Calculator (copyrighted 1896 by F. E. Smith and R. G. Manifold) in which the scales are set apart that there may be no confusion between them to the beginner. For convenience, these scales are designated respectively by the terms, Scales A, B, C and D, as follows:

Scale A, Circular Mils and B. & S. Gauge numbers.
Scale B, Volts lost.
Scale C, Feet one way.
Scale D, Amperes.

As is well known, the slide rule consists of a rigid

backing of card board, wood or celluloid, firmly secured to which are scales A and D (Figure 1) into grooves on the inner sides of which slides a second rule bearing scales B and C and the manipulation of the calculator merely consists in moving the slide bearing the scales B and C until a given factor on scale C for instance is set opposite a given factor on scale D when the quantities appearing opposite each other on scales A and B will show the results arising from the assumed condition. A simple example will illustrate clearly the mode of using the slide rule calculator:

First example: It is desired to transmit 50 amperes a distance of 400 feet with a loss of 2 volts; required, the size of the conductor.

Before proceeding to a solution of the problem it should beobserved that the Smith-Manifold Calculator contains the factors that are common to every problem that may arise in the determination of characteristics of direct currents and these factors are fundamental in that they are represented in volts, amperes and Ohms (feet) rather than in percentages of loss and lamps. Bearing this in mind, and referring again

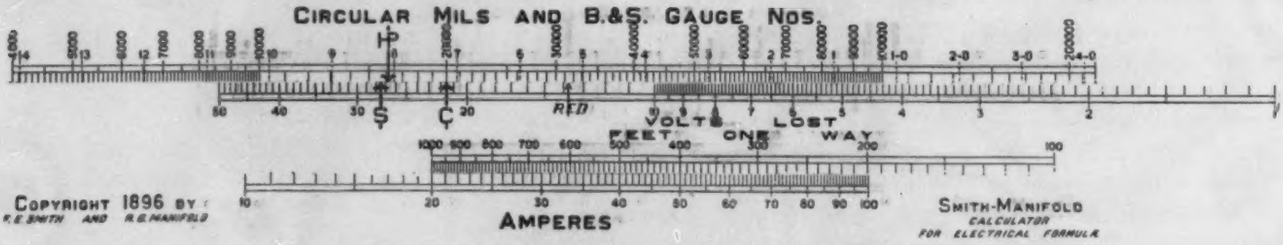

FIGURE 2.—THE SMITH MANIFOLD CALCULATOR.

to the problem above, on scale C find the unit marking 400 feet, which line is to be set opposite the 50-ampere line appearing on scale D. This is a simple process consisting merely of drawing out the slide containing scales B and C until the 400-foot mark is opposite the 50-ampere mark as shown fully in Figure 2. Now look along scale B and find the line marking 2 volts loss opposite which on scale A it appears that the required size of wire a trifle above No. 0000; to be more exact, and to express the required sizes of wire in precise circular milage it will be seen that the two volt loss mark is a trifle above the center of the division between 210,000 circular mils and 220,000 circular mils, hence the required size of the wire is 216,000 circular mils, or practically a No. 0000 B. and S. wire.

Following the same lines of procedure and with the same setting of the rule it will be seen at a glance that with

3 Volts.	Loss.	Size of Conductor required is			.....	143,000 C. M.
4 "	"	"	"	"	.....	108,000 " "
5 "	"	"	"	"	.....	87,000 " "
6 "	"	"	"	"	.....	72,000 " "
7 "	"	"	"	"	.....	62,000 " "
8 "	"	"	"	"	.....	54,300 " "
9 "	"	"	"	"	.....	48,300 " "
10 "	"	"	"	"	.....	43,300 " "

The manipulation of the Smith-Manifold Calculator is merely one of practice and of following the equally simple rules as that exemplified in the solution of the above problem. In order to show more fully, however, the completeness of the calculator as a pocket compendium including tables for the determination of the weights, dimensions and properties of wires in addition to the calculation of their functions the following partial list of the problems readily solved thereby is given, and in the ensuing articles of this series will be presented instructions for the manipulation of the calculator in each and every instance.

OHM'S LAW.

1. Given resistance and voltage to find amperes.
2. Given volts and amperes to find resistance.
3. Given resistance and amperes to find volts.

ELECTRIC POWER.

4. Given amperes and volts to find the horse-power.
5. Given horse-power and volts to find the amperes.
6. Given horse-power and amperes to find the volts.

WIRE TABLES.

7. Given the size of wire to find its carrying capacity at 2,000 amperes per square inch.
8. Given the size of wire to find its carrying capacity at 1,000 amperes per square inch.
9. To reduce circular mils to square mils.
10. To reduce square mils to circular mils.
11. Given the circular mils to find the diameter.
12. Given the diameter to find the circular mils.
13. Given the diameter to find the square mils.
14. Given the square mils to find the diameter.
15. To find equivalent sizes of wire.
16. Given the size and number of strands in a cable to find its circular mils.
17. Given the size of wire to find its weight per 1,000 feet.
18. Given the size of wire to find its resistance per 1,000 feet.
19. Given the size of wire to find its weight per mile.
20. Given the size of wire to find its resistance per mile.
21. Given the weight per 1,000 feet to find the size.
22. Given the size to find the feet per Ohm.
23. Given the size to find the feet per lb., etc., etc.

WIRING FORMULAE.

24. Given the amperes, distance and volts lost to find the size of wire.

25. Given the amperes, distance and size of wire to find the volts lost.

26. Given the amperes, volts lost and size of wire to find the distance.

27. Given the distance, volts lost and size of wire to find the amperes.

HYDRAULICS.

28. Given the cubic feet of water per minute, the head in feet, and the water wheel efficiency to find the horse-power.

29. Given the head, the horse-power and the efficiency to find the cubic feet of water required.

30. Given the horse-power, efficiency and cubic feet of water available to find the head required.

31. Given the horse-power, head and cubic feet of water to find the efficiency.

32. Given the miners inches of water, the head in feet and the water wheel efficiency to find the horse-power.

33. Given the head, the horse-power and the efficiency to find the miners inches required.

34. Given the horse-power, efficiency and miners inches available to find the head required.

35. Given the horse-power, head and miners inches of water to find the efficiency.

(To be continued.)

THE PUBLIC AND "THE INFANT SCIENCE."

BY DONALD H. FRY.

It may be a matter of interest to the readers of the "Journal" to know how exceedingly ignorant the public is on matters pertaining to machinery and electricity. At the recent Mechanics Fair, held in San Francisco, the questions asked and remarks made about the Union Iron Work's exhibit—a vertical compound engine direct connected to a Siemens and Halske dynamo—will serve to illustrate how well the average man is versed in electrical matters. The inquiries given below are given verbatim:

The following one-sided conversation which took place between a well dressed gentleman—evidently a professional man—and the lady he was escorting, gave the attendant the idea of taking notes of some of the remarks made.

"An electrical machine?" he asked the attendant in a manner calculated to impress the lady with his knowledge rather than that he asked for information. Then turning to the lady, "You see the electricity is formed by the friction of those copper bars,—technically termed brushes—pressing on that large copper ring, which is called a commutation ring."

"What is that shiny stuff?" asked the lady pointing to the revolving spider.

"Oh, that is composed of electric wires which protrude from each of the segments thereby forming circuits for the electrical currents to pass through."

"Oh, I see," said the lady with child-like credulity.

Here are a few samples of the many questions asked:

"Is that the Union Crushing machine?"

"Is it a quartz machine?"

"Are you polishing that metal?" pointing to the commutator.

"Where do you get the power from?"

"Do they (the dynamo and engine) run well together?"

"Are those things (indicating the cross-heads) electrical pumps?"

"Does that dynamo run the engine?"

"That's a marine engine, isn't it?" I suppose that is why they call it Siemen's system.' "

"Which is the engine and which is the dynamo?"

"Are those things (brushes) brakes?"

"Is it water or steam you use in that thing? (cylinders). Don't you use water? I thought that you had to use water when making electricity to make it cool quicker."

"Now, young man, I have studied electricity quite extremely myself, but there is one thing that sticks me,—how does the electricity get to the lamps after you have made it? Does it run along the wires?"

"Couldn't you get enough power out of that dynamo to run a steam engine?"

"How many volts does it make a minute? How many cars would it pull?"

"That machine runs on ball bearings, doesn't it? Now, I can't understand how that inside stands still and the outside runs on the ball-bearings."

And then the authors of these bright remarks usually went away observing: "Electricity is a great thing. Has an unlimited field, but it is still in its infancy."

Two old countrymen with long flowing whiskers and "high-water" pants afforded some amusement. After gazing at the machine for some time one ventured to ask, "Now, young man, can you tell me what material makes electricity—same as fuel makes fire? If there is any secret about this machine, of course I don't want to know it, but if you don't mind telling me, why I should like to know. That wooded box—(the cylinders and steam chest were encased in wood)—I suppose is full of acids and copper and zinc and things. Isn't it?" While the attendant was gasping for breath the second old man came to the rescue with:—

"I though ma'be that it went so fast that it created its own combustibles. A very little of your electric stuff would do the work,—she is pretty big and she is going blamed fast, by gum!"

This morning a conductor on a University car nearly died with heart disease when a woman stepped off his car at the corner of First and Spring streets like a man, instead of getting off with her face turned toward the rear platform. The conductor was taken to the Receiving Hospital. The doctors are under the impression that the shock was too great, even for a conductor to stand.—Los Angeles Herald.

Transportation

SAN DIEGO, CAL.—The San Diego Electric Railway Company, in connection with the Southern California Mountain Water Company, has submitted a proposition to the city to furnish water and sprinkle certain streets at one-half the present cost, and if the proposition is accepted either salt or fresh water will be used. The plan includes the laying of a 10-inch main from the power house up "D" street to Seventh, thence north to Ash street, where a 250,000-gallon steel reservoir will be erected at an elevation of 160 feet, from which will be laid distributing mains for salt water.

LOS ANGELES, CAL.—The Pasadena & Pacific Electric Railway system extends from Altadena to South Santa Monica, a distance of a fraction over thirty-five miles. This is believed to be the longest electric railway in the United States. ——The Board of Fire Commissioners has granted Witmer Brothers permission to operate an electric power plant in the Second street power house.——The erection of the new 1000 h. p. engine to operate the 800 k. w. Walker generator, being installed in the Los Angeles Railway Company's power house, is being completed.——Ten new double-end cars have been added to the equipment of the railway company.——Three new 500 h. p. boilers are being installed in the railway power house.

LOS ANGELES, CAL.—The general offices of the Los Angeles Railway Company have been removed from the Central avenue power house, thereby increasing the engine-room nearly one-half. The present steam equipment consists of one 1000 h. p., two 600 h. p. and one 250 h. p. engines, driving various Westinghouse and Edison generators, and also a Walker 800 k. w. generator.——The Westinghouse Company has sold twenty-eight single and seven double "12A" equipments for use in this city.——Work is progressing rapidly on the new and permanent power house for the Los Angeles and Santa Monica Electric Road at Sherman.——The Traction Company is making a double track extension westerly from the present terminus at Vermont avenue. The new track will run out Vine street, thence west to Rosedale street, south to Adams, west to Western avenue and south on Western avenue to Jefferson street. It is thought that it is the intention to extend the road to Redondo, or possibly Santa Monica.——It is believed that the Main street line will be extended to the University.

CITY OF MEXICO, MEXICO.—The Federated Street Railway system was formally turned over to the new company on August 18th. Thomas H. McLean is President and General Manager, and the general offices will continue to be located at Santa Clara, No. 12.——Modern Mexico has the following to say regarding the transfer: "The purchase of the street railway system of the City of Mexico by American capitalists comprises the sole right-of-way of the desirable streets of the city, together with the following mileage and equipment: One hundred miles of broad-guage track, 60 miles of narrow-guage track, 5 locomotives, 300 passenger cars, 80 freight cars (with privilege of carrying all classes of freight), 40 carts, 2600 mules and horses and 30 funeral cars. The number of passengers carried in 1895 was 17,480,425, at fares ranging from 6 to 31 cents per passenger; number of employees at present, 2100. The parent road has always paid a dividend of from 6 to 7 per cent. since organization, besides putting aside sufficient surplus out of its earnings to enable it to purchase all competing lines, except one small and undesirable single-track road of about four miles in length. The first buyer was Channing F. Meek, of New York, who sold the lines to Henry A. Butters, of San Francisco, Cal. The transaction, including the contemplated re-equipment and improvement of the lines, will involve about $20,000,000 (silver), but the actual purchase price is stated at $7,750,000."

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Abbreviations: Illustrated (*); Editorial, (Ed.); Educational, (Educ.); Electro-Economics, (Elec-Econ.); Electro-Insurance, (Elec-Ins.); Electro-Therapeuty, (Elec-Ther.); Financial, (Fin.); Hydraulics, (Hyd.); Illumination, (Ill.); Literature, (Lit.); Metallurgy, (Met.); Mining, (Mi.); Passing Comment, (P. C.); Physics, (Phys.); Pneumatics, (Pneu.); Telegraphy, (Teleg.); Telephony, (Telep.); The Trade, (T.); Transmission, (Transm.); Transportation, (Transp.)

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